P/I band multi-frequency reflectometry antenna for a U-class constellation

Completed Technology Project (2018 - 2019)

Project Introduction

Soil Moisture is declared an Essential Climate Variable (ECV) by the World Meteorological Organization. Root zone soil moisture (RZSM), in particular, is critical for understanding hydrologic fluxes linking surface and subsurface processes and the interplay between the water and carbon cycles. Only near-surface (0-10 cm) soil moisture is available through current spaceborne remote sensing, with data assimilation relied upon to produce RZSM as level-4 data products. P-band SAR has the potential to measure deeper moisture from space, although radio spectrum restrictions currently prohibit transmission over Europe and North America. Signal-of-Opportunity reflectometry has emerged as a third method of spaceborne microwave remote sensing combining features of active and passive remote sensing. SoOp operates as an active remote sensing technique in a forward reflection bistatic configuration exploiting pre-existing signal sources. Spacebased sources at these frequencies include LEO text-messaging satellites (137-138 MHz) and government narrowband and broadband geosynchronous communications satellites (240-270 MHz and 360-380 MHz). On the other hand, the hardware is passive (receive only) and the measurand of forward reflectivity is linked by Kirchoff's law and conservation of energy to emissivity. A great advantage of SoOp is that these features enable low-power instruments to meet link budgets with sufficient margin using relatively small wire-type antennas. We propose to develop a deployable broadband antenna covering 137-380 MHz (P/I bands) with industry partner MMA Design for use in a SoOp instrument constellation. The resulting technology will be compatible with U-class satellite borne SoOp instruments. We envision a train of 6-U satellites, each with two antennas and tri-band SoOp receivers in high-inclination low-Earth orbit for measuring surface reflectivity for retrieving soil moisture and other surface parameters. The deployable antenna uses innovative printed-circuit membrane technology to achieve 1-U stowed volume. We will investigate two antenna types: Broadband Crossed Dipole Membrane Antenna (BCMA) and Log-Periodic Dipole Array (LPDA). Following downselect, a sub-scale model will be built and tested, to validate the design of both the electromagnetic (EM) properties of the antenna and mechanical design of the deployment mechanism. We will enter at TRL 2, mature the technology during a two-year period of performance (Jan. 2018 to Dec. 2019), and exit at TRL 4.

P/I band multi-frequency reflectometry antenna for a U-class constellation

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

Purdue University-Main Campus

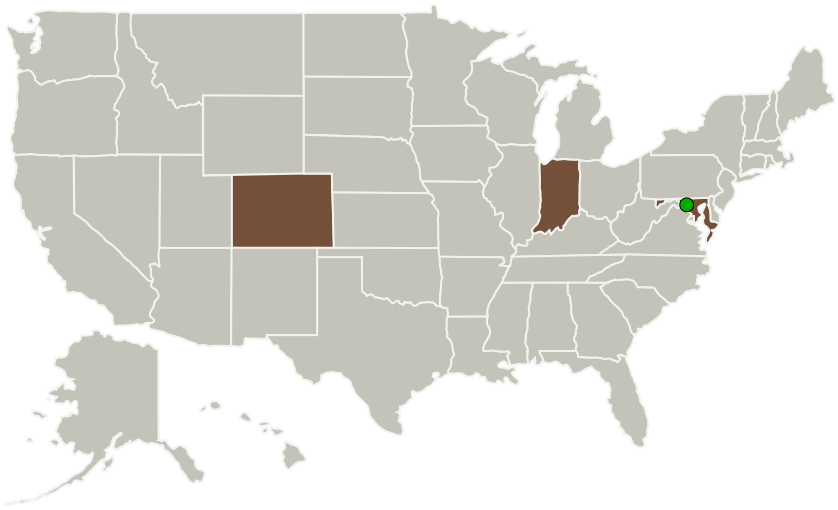
Responsible Program:

Advanced Component Technology Program

P/I band multi-frequency reflectometry antenna for a U-class constellation

Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Purdue University-Main Campus	Lead Organization	Academia	West Lafayette, Indiana
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
MMA Design LLC	Supporting Organization	Industry	Loveland, Colorado

Primary U.S. Work Locations	
Colorado	Indiana
Maryland	

Project Management

Program Director:

Pamela S Millar

Program Manager:

Amber E Emory

Principal Investigator:

James Garrison

Co-Investigators:

Jeffrey R Piepmeier
Michael R Ludwig
Manuel A Vega Cartagena
Christopher A Pelzmann

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.2 Radio Frequency
    - TX05.2.6 Innovative Antennas

Target Destination

Earth